converted into a solid waste disposal area in 1957. By 1977, over 6 million pounds of uranium had been put into drums and placed in this disposal area.

PGDP had no integrated waste management program until the early 1980s. Before then, waste disposal was performed by each organization performing work in conjunction with the Maintenance Department, which operated several disposal sites. When requested by the operating departments, limited guidance was provided by the site safety and health organization.

In 1978, the site Environmental Control Department conducted a study of PGDP waste management practices. The report recommended better management of solid waste, closure of miscellaneous burial areas, improved management of existing facilities, provision of additional space for facilities, and construction of facilities for recovery and reduction of waste. The report stated that the passage of the Resource Conservation and Recovery Act (RCRA) in 1976 required Federal facilities to comply with all state solid waste regulations and that the Plant "is only partially meeting both present and planned regulations." In part, this study led to the creation of the Material Terminal Management (MTM) Department within the Maintenance organization. The MTM Department implemented the integrated waste management program by gaining control of waste management facilities and developing waste management procedures for the Plant.

The 1978 study and the formation of the MTM Department also impacted the disposal of radioactive waste on site. In 1978 and 1979, the amount of radioactive waste disposed of on site was 330,690 pounds annually, but this declined significantly to 18,000 pounds per year in the 1980s. An overriding assumption regarding the stability of the radioactive disposal sites was that the underlying clay layer would prevent contamination from leaching into the groundwater and travelling off site.

In the early 1980s, the MTM Department began addressing hazardous waste disposal practices by working with waste generators to ensure that waste streams would be in compliance with RCRA requirements and by implementing standard practice procedures for waste management. Concurrently, the MTM and the Environmental Control Departments worked with regulators to obtain permits for storage, treatment, and disposal facilities, including the C-400 gold dissolver precipitation system and C-410 neutralization pit. Legacy hazardous waste was brought to several locations, including the C-733 Hazardous Waste Storage Area, the C-746R Waste Solvent Storage Area, and the C-746Q Hazardous Waste Storage Area. However, the absence of sufficient characterization to ensure long-term storage and compliance with disposal acceptance criteria has led to existing hazardous waste storage problems and the need for significant recharacterization.

PCBs, which were in widespread use by the Plant throughout its early history, were not considered a hazard nationwide until the early 1980s. In 1980, the newly formed MTM Department performed the first sitewide PCB inventory in response to new Toxic Substances Control Act (TSCA) regulations on PCBs. By 1982, a PCB program was established that addressed PCBs as an environmental contaminant and a regulated waste.

Based on site records, there was a clear understanding in the 1950s that materials contaminated above certain limits could not be released to the public. Procedures were used to govern the handling of scrap materials, which were generally categorized into one of four groups: classified scrap, unclassified clean scrap, unclassified contaminated scrap, and unclassified nonmetal scrap. However, there was a concern in the mid-1970s that the contaminated items were being released to public parties as part of equipment and scrap sales. In mid-1975 a Scrap Handling Committee was established to evaluate onsite solid waste disposal problems. The source of these problems included the ongoing upgrade program, lack of awareness of the proper procedures – especially among new workers and supervisors – and an increase in the number of entities hauling waste to the scrap yards. The Scrap Handling Committee also examined the effectiveness of equipment and scrap sales to the public, and despite recommendations for improvements, continued problems were evident in 1977. The extent to which proper procedures were not followed, combined with the small number of health physics personnel, suggests that materials exceeding proper radiological limits were likely released off site until the late 1980s.

2.7 Air and Water Emissions

Radioactive air emissions began with startup operations in 1952 and have continued to present. Air emissions from the site were released from process stacks, diffuse and fugitive emission sources, accidental releases, and a limited number of planned releases. No evidence of measurements or monitoring of stack emissions was found prior to 1975. From 1959 to 1974, the air emission reports consisted of ambient air monitoring. Starting in mid-1960, continuous ambient air samples were taken at four locations at the perimeter fence and were analyzed for alpha and beta

contamination to provide input for annual reports on ambient air concentrations. In 1961, four additional ambient continuous air samplers were installed one mile outside the perimeter fence, although actual stack monitoring of emissions did not occur until the mid-1970s.

From 1975 through 1990, annual discharges to the atmosphere based on stack measurements were reported in annual emission reports. It has been estimated that from 1952 to 1983, 60,000 kg of uranium were released to the atmosphere, 75 percent of this prior to 1965 and most from C-410 and C-340. A number of accidental releases of UF_6 occurred (perhaps as many as 15), during which more than 50 pounds of UF_6 were released. Dust and fugitive emissions were generally not calculated for the site from 1952 to 1990.

Fluorine emissions to the atmosphere also commenced with startup operations in 1952 and have continued to the present. These emissions were from process stacks, diffuse and fugitive emission sources, accidental releases, and a limited number of planned releases. During the period from 1959 to 1990, the air emission reports consisted of ambient air monitoring results for fluorides. Starting in mid-1960, continuous ambient gaseous air samples were taken at four locations at the perimeter fence and were analyzed for gaseous fluorides to provide input for annual reports on ambient air concentrations. Only limited information could be found for stack emissions of fluoride prior to 1986. The first environmental reporting of stack emissions of fluorine that was found addressed 1986 emissions. For the period 1986 through 1990, discharges to the atmosphere based on stack measurements were reported in annual emission reports.

Construction of the PGDP incorporated systems and strategies for disposing of liquid effluents from production and support operations. Liquid effluents were released in a number of ways, including via the sanitary sewage and storm water drainage systems. The C-615 sewage treatment plant was used from the beginning to treat sanitary and sink wastes from production buildings. Other effluents were discarded either in batches or through continuous feed into ditches, ponds, and streams, with subsequent flow into the Big and Little Bayou Creeks, ultimately reaching the Ohio River.

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Liquid effluent discharge limits for radionuclides have always been controlled under the AEC and ERDA regulations and later DOE orders as maximum permissible concentrations (MPCs) or radiation concentration guides (RCGs) in water. A review of historical correspondence identified instances where specific decisions were made to discharge waste materials containing uranium, transuranics, and fission products directly to local ditches.

Federal and Commonwealth of Kentucky requirements on chemical discharges from the Plant did not exist during the early years of operations, and the Plant discharged significant amounts of hazardous chemicals, such as TCE and chromium. One of the major components of liquid process waste during early Plant operations was recirculating cooling tower blowdown water—approximately 500,000 gallons per day, with a 20 ppm concentration of chromium, was pumped to the Little Bayou Creek. As a result, there was a time when parts of the Little Bayou were dead and colored yellow from the chromium.

In the early 1970s, the Clean Water Act established the National Pollutant Discharge Elimination System (NPDES), which administered effluent limitations and water quality requirements for chemical releases. A total of 18 outfalls were permitted at the site. In response to changing expectations for environmental protection, in 1977 the C-616 Wastewater Treatment Plant came on line. Major liquid effluent streams that feed into the North-South Diversion Ditch were then routed by a lift station to this facility, resulting in significantly better water quality in local streams.

The most significant liquid effluent discharge source at the site was from the C-400 decontamination building. Wastes from this source included TCE from degreasing operations, contaminated liquids from cleaning operations, and various contaminated raffinate solutions from uranium, neptunium, and technetium recovery operations. Essentially all isotopes at the site were present in various portions of this facility and in its liquid waste streams, including uranium, neptunium, plutonium, thorium, and technetium.

In 1988, concerns over residential water quality led to sampling of residential wells north of the Plant.

TCE, an industrial degreaser, and technetium-99, a radionuclide fission product from nuclear fuel, were discovered in the wells. This discovery prompted the government to provide municipal water free of charge to all residences and businesses in an area bounded by the Ohio River to the north, by the DOE property to the south, by Metropolis Lake Road to the east, and by Bethel Church Road to the west. Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), DOE and the EPA developed an Administrative Consent Order, effective November 23, 1988, that established a schedule to investigate and remediate offsite groundwater contamination. Phase I of the CERCLA review, conducted in 1989 and 1990, identified contaminants of concern and solid waste management units (SWMUs) that could have contributed to offsite contamination, outlined the physical characteristics of the SWMUs, and described the risk of offsite contamination. Phase II of the CERCLA review, conducted in 1990 and 1991, further assessed the risk of offsite contamination, characterized SWMUs that could have contributed to offsite contamination, and identified migration pathways for contaminants.

2.8 Key External Assessments

In April 1985, a DOE task force evaluated the adequacy of practices to support handling of radioactive contaminants in uranium recycle materials at the Oak Ridge Y-12 Plant, the Feed Materials Production Center (in Fernald, Ohio), and the RMI Company (in Ashtabula, Ohio), and examined past operations at the PGDP and the Portsmouth Oxide Conversion Facility. The task force concluded that an in-depth examination of PGDP handling and processing practices was warranted, that quantities of recycle materials with undetermined levels of contaminants were present at PGDP, and that PGDP was periodically receiving commercially-produced UF_6 containing trace levels of transuranic elements. This study recommended that PGDP line management assess worker exposures to transuranic elements and fission products from processing of recycled materials and recommend a feasible method for disposing of uranium recycle material.

An overall concern regarding ES&H conditions at all DOE sites led then-Secretary of Energy Watkins to establish the Tiger Team program and to conduct a Tiger Team assessment of PGDP in June and July 1990. The assessment concluded that ceasing PGDP operations was not warranted, that compliance issues were known by those Federal and State agencies that issue permits, and that the following ES&H and management issues required prompt attention: (1) environmental monitoring and evaluation programs were not being effectively implemented due to a lack of technical direction, formal procedures, and a coordinated quality assurance program; (2) formal procedures for implementing environmental protection activities were lacking, and quality assurance programs had not been implemented for many environmental activities; (3) compliance with DOE orders and mandatory standards for worker safety and health was deficient, as was the system for managing administrative control documents; (4) training and certification programs did not meet site needs; (5) instrument calibration practices did not always meet minimum standards; (6) there was no long-range plan for safe storage of UF_6 cylinders; (7) no integrated sitewide management system was available to track and correct identified deficiencies; (8) DOE was not effectively performing oversight to ensure that ES&H initiatives were being implemented; and (9) the site contractor did not have a corporate strategic plan to accomplish DOE's ES&H objectives.

These issues became the framework for the site's ES&H activities for much of the decade of the 1990s. The site's effectiveness in addressing these concerns, the current ES&H posture of the site, and the transition of the site's uranium enrichment operations to a privatized enterprise (USEC) are documented in the Office of Oversight's report from the first phase of this investigation (*Phase I Independent Investigation of the Paducah Gaseous Diffusion Plant: Environment, Safety, and Health Issues,* October 1999). A detailed discussion of historic hazards at PGDP; operational, maintenance, and environmental activities and practices; and the effectiveness of these practices in addressing historic hazards is provided in Sections 3 and 4 of this report.